

STUDIES IN THE GENUS *Phellinus*. I. THE IDENTITY OF *Phellinus rickii* WITH NOTES ON ITS FACULTATIVE SYNONYMS

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ABSTRACT

The name *Phellinus rickii* (Bres.) David et Rajchenb., based on *Poria rickii* Bres., is a later homonym of *Phellinus rickii* Teix. and renamed *Phellinus tropicalis* M. Lars. et Lomb. The facultative synonyms of the Bresadola name, *Phellinus glaucescens* Petch and *Phellinus flavomarginatus* (Murr.) Ryv., were found to represent distinct species. We consider *Phellinus ferrugineovelutinus* (Henn.) Ryv. to be a *nomen dubium*. A cultural description of *P. tropicalis* is provided.

Key Words: *Phellinus rickii*, *P. tropicalis* nom. nov.

In a recent report, David and Rajchenberg (1985) proposed that the combination *Phellinus rickii* (Bres.) David et Rajchenb., based on *Poria rickii* Bres. (Bresadola, 1920), replace the presumed earlier synonym *Phellinus ferrugineovelutinus* (Henn.) Ryv., the type of which is sterile. However, that combination is a later homonym of *Phellinus rickii* Teix. (Teixeira, 1950). Furthermore, several names of *Phellinus* species are considered to be facultative synonyms of *Poria rickii*. David and Rajchenberg (1985) reported that *Phellinus glaucescens* Petch is "identical" to *Poria rickii*. Ryvarden and Johansen (1980) listed *Phellinus flavomarginatus* (Murr.) Ryv. as a synonym of *P. ferrugineovelutinus*.

Our purposes here are (1) to resolve any question concerning the possible synonymy of *Phellinus rickii* (Bres.) David et Rajchenb. with *P. rickii* Teix., and (2) to determine whether any of the proposed facultative synonyms would be an appropriate binomial in *Phellinus* to replace that used by David and Rajchenberg (1985).

MATERIALS AND METHODS

Microscopic characters of basidiocarps were studied from freeze-microtomed sections mounted either in 2% KOH, 1% phloxine B, 1% cotton blue (Johansen, 1940) to test for cyanophily of basidiospores, or in Melzer's reagent (Melzer, 1924, IKI) to test for amyloid or dextrinoid reactions of basidiocarp microstructures.

¹ Maintained at Madison, Wisconsin, in cooperation with the University of Wisconsin.

Nomenclatural types were studied for all species names. Illustrations were prepared with the aid of a Zeiss drawing tube. Capitalized color names are from Ridgway (1912), and herbarium designations are from Holmgren *et al.* (1981). Diagnostic characters are italicized to emphasize important differences between the species studied.

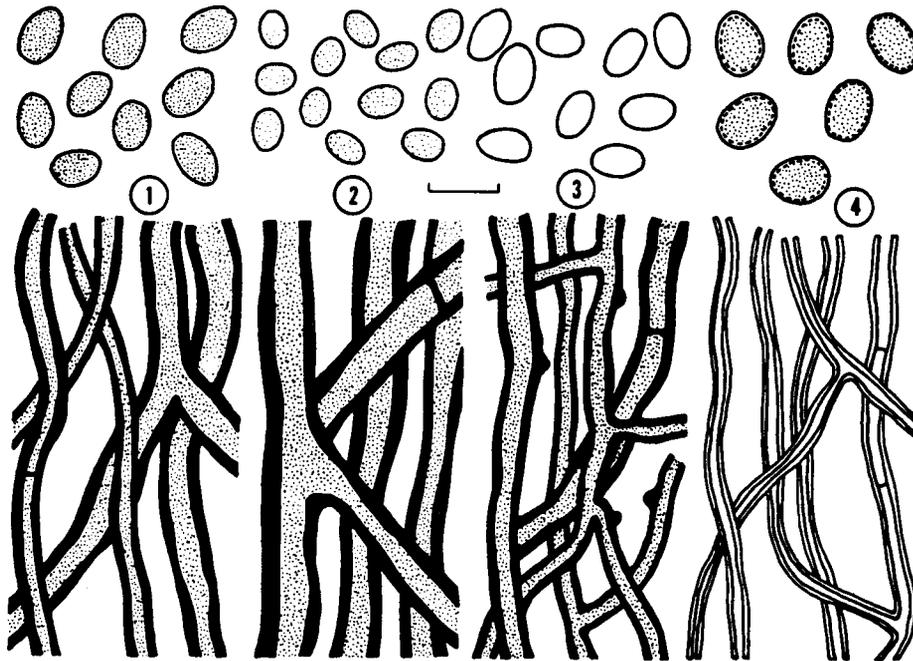
The methods employed in studying the cultures were the same as used in previous studies (Davidson *et al.*, 1942). The Key Patterns were based on 2-wk-old cultures inoculated in the centers of Petri dishes on 130 malt extract agar (MEA) and incubated at 25 C. The Species Code of Nobles (1965) was based on 6-wk-old cultures inoculated at the sides of the dishes. Extracellular oxidase production was detected by the Bavedamm test described by Davidson *et al.* (1938), in which the cultures were grown on malt agar containing 0.5% gallic (GAA) or tannic (TAA) acids. For the constant temperature study, cultures on MEA were placed in incubators at eight temperatures ranging from 16–44 C 24 h after plating and measured at the end of 7 da. Mat diameters are averages of three replications.

TAXONOMY

Phellinus rickii Teixeira, *Bragantia* 10: 120.
1950. FIG. 1

HOLOTYPE: Brasil, Prov. R. G. Sul, Sao Leopoldo, "in truncis putridis," Bresadola 282, 1905 (SP, 28309).

Basidiocarp perennial, distinctly pileate, appanate, attenuated to 3 cm at point of attach-



FIGS. 1-4. Basidiospores and context hyphae (as viewed in 2% KOH). 1. *Phellinus rickii*. 2. *P. tropicalis*. 3. *P. flavomarginatus*. 4. *P. glaucescens*. Scale bar equals 5 μm .

ment to the substrate, 7 \times 8 \times 2.5 cm; pileus surface concentrically ridged and zonate, dull blackish brown, becoming dull yellowish brown toward the obtuse margin; pore surface dull yellowish brown, paler and brighter toward the margin; pores 4-5 per mm; tube layer indistinctly stratified; context yellowish brown, up to 1 cm thick; all parts darkening in 2% KOH.

Clamp connections absent throughout. Hyphae of the context of two kinds: generative, 2-3.5 μm diam, simple-septate, pale yellowish brown; skeletal, 2.5-3.5(-4) μm diam, thick-walled, dull brown; tramal hyphae similar to skeletal, 2-3 μm diam, in parallel arrangement; basidia 6-7 \times 3.5-4 μm , short-clavate, 4-sterigmate; basidiospores 4-4.5 \times 3.5-4 μm , broadly ellipsoid to subglobose, thin-walled, pale to dull brown in 2% KOH (not pigmented when observed in IKI or distilled H_2O), inamyloid, acyanophilous; hymenial setae ventricose, 12-20 \times 4.5-6.5 μm , projecting 2-6 μm , dark brown.

Phellinus tropicalis M. Larsen et Lombard, *nom. nov.*

FIG. 2

= *Poria rickii* Bres., *Ann. Mycol.* 18: 37. 1920.
[= *Phellinus rickii* (Bres.) David et Rajchenb., *Mycotaxon* 22: 288. 1985. (later homonym)]

HOLOTYPE: Brasil, Sao Leopoldo, in ligno frondoso, J. Rick 14, 1906, "typus" (S); isotype in BPI.

Basidiocarp annual ("or occasionally persisting a second year," *teste* Lowe, 1966), *resupinate*, up to 5 mm thick; pore surface dull brown and becoming paler toward the margin; pores 7-9 per mm; tube layer up to 4 mm thick; context bright reddish brown, up to 1 mm thick; all parts darkening in 2% KOH.

Clamp connections absent throughout. Hyphae of context of two kinds: generative, 2.5-3.3(-4) μm diam, thin-walled, simple-septate, pale yellowish brown; skeletal, 3.5-4(-4.5) μm , thick-walled, infrequently simple-septate, dull yellowish brown; tramal hyphae similar to skeletal except most hyphae thin-walled and parallel in arrangement; thick-walled, dark brown hyphae associated with origin of hymenial setae; basidia 5-6 \times 3-4 μm , short-clavate, 4-sterigmate; basidiospores 3 \times 2.5 μm , subglobose, thin-walled, pale yellow to pale brown in 2% KOH (not pigmented in IKI or distilled H_2O), inamyloid, acyanophilous; hymenial setae (10-)12-14 (-20) \times 5-7 μm , abundant, ventricose, projecting up to 8 μm , dark brown; setae also occurring in clusters or fascicles around pore apertures.

ADDITIONAL SPECIMENS EXAMINED: BRASIL Sao Leopoldo, on angiospermous wood, J. Rick 423 (S; cited in original description and bearing "Paratype" on packet, but is not the same fungus as the holotype); Rio Grande do Sul, on hardwood, J. Rick, 1923 (BPI; US 241958); (location not given), on hardwood, J. Rick, 1923 (BPI; US 024 1934); Sao Leopoldo, on hardwood, J. Rick, 1930 (BPI; US 02421 10); Sao Leopoldo, Rio Grande do Sul, on hardwood, J. Rick 1930 (BPI; US 0242111). COSTA RICA: Tacaes near Animas, Heredia Prov., on hardwood, J. L. Lowe 13465,² 16.viii.1963 (CFMR, SYRF).

Description of culture.

Key patterns. — B-P-I-10, B-P-M-7-10

Species code. -2.6.7.(17).32.37.39.43.54.

Growth characteristics. —Growth on MEA moderately rapid to medium, forming mats 89–90+ mm diam in 2 wk; mats white at 1 wk, creamy white (near Marguerite Yellow) by 2 wk, Deep Colonial Buff to Yellow Ocher by 6 wk, appressed, short-downy, homogeneous, adherent; margins even, indistinct; odorless; no reverse discoloration by 2 wk, Honey Yellow to as deep as Mars Brown in streaks and patches by 6 wk; oxidase reactions positive, at 1 wk strong on GAA, making no growth to a trace³ of growth, moderately strong on TAA, forming mats 24–32 mm diam.

Hyphal characteristics. —All hyphae staining in phloxine, simple-septate, of two types: (a) generative hyphae, walls thin, hyaline or pale brown, some cells with walls slightly thickened and contents dark brown, 2–4.5(-6) μm diam; (b) skeletal (?), walls dark brown and slightly thickened, aseptate or sparingly septate, branched, 1–2 μm diam; setae rare or absent, brown, narrowly subulate, somewhat thin-walled, 30 \times 4.5 μm .

Temperature relations. —Average mat diam at 8 constant temperatures: 16 C, 14.7 mm; 20 C, 32.7 mm; 24 C, 51.3 mm; 28 C, 71.7 mm; 32 C, 80.3 mm; 36 C, 81.0 mm; 40 C, 42.0 mm; 44 C, no growth but not killed. Optimum 36 C.

PHELLINUS FLAVOMARGINATUS (Murr.) Ryv., *Norw., J. Bot.* 19: 234. 1972. FIG. 3

≡ *Fomitiporia flavomarginata* Murr., *North American Fl.* 9 (1): 11. 1907.

HOLOTYPE: Cuba, Alto Cedro, Santiago de Cuba,

² Specimen from which a polysporous isolate was obtained and used in this study.

³ Less than 11 mm diam including 4-mm inoculum plug.

on dead wood in a low dense virgin forest, F. S. Earle and W. A. Merrill, no. 559, 19–20.iii.1905 (NY).

Basidiocarp resupinate, annual (several parts of the type show two layers of tubes, probably caused by alternating wet and dry periods), up to 6 mm thick, hard and brittle; pore surface umbrinous; pores 7–9 per mm; tube layer up to 6 mm thick; context less than 1.0 mm thick, reddish brown with a thin black zone near the substrate; margin bright rusty brown, 1–2 mm wide, pubescent; all parts darkening in 2% KOH.

Clamp connections absent throughout. Hyphae of the context of two kinds: generative, 1–1.5 μm diam, thin-walled, simple-septate, hyaline to pale yellow; *skeletal*, 2–3(-3.5) μm diam, dull reddish brown, thick-walled, branched and intertwined, simple-septate but walls often with protuberances that superficially resemble clamp connections, tramal hyphae 3.5–4 μm diam, thick-walled, with parallel arrangement, dull ferruginous brown; basidia 5–6 \times 4.5–5 μm , subglobose, 4-sterigmate, hyaline; *basidiospores* 3–3.5(-4) \times 2–2.5 μm , broadly ellipsoid to subglobose, flattened adaxially, thin-walled, hyaline in 2% KOH (not pigmented in H₂O or IKI). inamyloid, acyanophilous; hymenial setae rare, 16–18 \times 6.5–7.5 μm , slightly ventricose, dark ferruginous brown, projecting beyond the hymenium up to 6 μm ; chlamydospores associated with tramal hyphae, intercalary, 7 \times 5 μm , broadly ovoid, truncate, thick-walled, pale to dull yellowish brown.

PHELLINUS GLAUDESCENS (Petch) Ryv., *Norw. J. Bot.* 19: 234. 1972. FIG. 4

≡ *Poria glaucescens* Petch, *Ann. Roy. Bot. Gard. Peradeniya* 6: 139. 1916 (K).

"COTYPE": Ceylon, Hakgala, on hardwood, T. Petch, May 1913 (K; no. 3563 cited in original description, not on packet).

Basidiocarp resupinate, up to 5 mm thick; pore surface greenish gray with some parts dull brown; margin narrow, pale tan to yellowish brown; pores 7–9 per mm; tube layer up to 5 mm thick; context not discernible; all parts darkening in 2% KOH.

Clamp connections absent throughout. Hyphae of the context of two kinds: generative, 1.5–2 μm diam, thin- to thick-walled, hyaline, branched, simple-septate; *skeletal*, 1–1.5 μm diam, thick-walled, hyaline in 2% KOH, rarely branched, septa infrequent; tramal hyphae 2(-2.5) μm diam, thick-walled, simple-septate, dark

brown, with parallel arrangement; basidia $6 \times 5 \mu\text{m}$, subglobose, 4-sterigmate, hyaline; basidiospores $3.5\text{--}4\text{--}(4.5) \times 3\text{--}3.5 \mu\text{m}$, broadly ellipsoid to subglobose. walls noticeably thickened in most spores, inamyloid, acyanophilous; pale yellowish brown to dull brown in 2% KOH (somewhat paler in distilled H_2O , IKI), hymenial setae $13\text{--}15\text{--}(18) \times 6\text{--}8 \mu\text{m}$, ventricose to ventricose-rostrate, thick-walled with walls becoming thinner towards apices, dull reddish brown.

PELLINUS FERRUGINEOVELUTINUS (Henn.) Ryv., *Norw. J. Bot.* 19: 234. 1972.

= *Poria ferrugineovelutina* Henn., *Hedwigia* 44: 59. 1905.

HOLOTYPE: Brazil, Rio Jurua, Jurua-Miry, on hardwood, E. Ule 2807, viii. 1901 (BPI, S).

Lowe (1966), Ryvarden and Johansen (1980), and David and Rajchenberg (1985) have all indicated that the type material is sterile. However, Ryvarden and Johansen (1980) used the name while citing *P. flavomarginatus* as a synonym. David and Rajchenberg (1985) interpreted *P. ferrugineovelutinus* as a *nomen dubium* or one that is of uncertain application, and we agree with this disposition of the name. Our study of the type material indicates that it possesses a series of characteristics common to numerous resupinate *Phellinus* spp. In the absence of basidiospores, however, the name cannot be applied with certainty.

DISCUSSION

We conclude from our studies of the types of the species in question that *Phellinus rickii* Teix. is distinct from *Phellinus rickii* (Bres.) David et Rajchenb. The basidiocarp of *P. rickii* Teix. is perennial, reflexed, and possesses larger basidiospores (TABLE I). Furthermore, *P. rickii* (Bres.) David et Rajchenb. is a later homonym. Since there appears to be no other available name for the Bresadola species, we propose the new name *P. tropicalis* M. Lars. et Lomb., typified by Bresadola's (1920) original material.

We further conclude that the synonymy of *P. glaucescens* with *Poria rickii* Bres., indirectly proposed by David and Rajchenberg (1985), is incorrect. (They stated that "... *glaucescens* ... is identical in all respects.") The basidiospores of *P. glaucescens* are larger, and context hyphae are hyaline. Apparently there was doubt, however, concerning this synonymy because David

TABLE I
SOME DIFFERENCES AMONG *PELLINUS RICKII*, *P. TROPICALIS*, *P. FLAVOMARGINATUS*, AND *P. GLAUDESCENS*

Species name	Size	Shape	Basidiospores		Context skeletal hyphae	
			Color*	Wall thickening (- or +)	Color in 2% KOH	Diameter
<i>Phellinus rickii</i>	$4\text{--}4.5 \times 3.5\text{--}4 \mu\text{m}$	Broadly ellipsoid to subglobose	Dull brown (I); hyaline (II, III)	-	Brown	$2.5\text{--}3.5\text{--}(4) \mu\text{m}$
<i>Phellinus tropicalis</i>	$3 \times 2.5 \mu\text{m}$	Subglobose	Pale yellow to pale brown (I); hyaline (II, III)	-	Brown	$3.5\text{--}4\text{--}(4.5) \mu\text{m}$
<i>Phellinus flavomarginatus</i>	$3\text{--}3.5\text{--}(4.5) \times 2\text{--}2.5 \mu\text{m}$	Broadly ellipsoid to ellipsoid	Hyaline (I, II, III)	-	Brown	$2\text{--}3\text{--}(3.5) \mu\text{m}$
<i>Phellinus glaucescens</i>	$3.5\text{--}4\text{--}(4.5) \times 3\text{--}3.5 \mu\text{m}$	Broadly ellipsoid to subglobose	Pale yellowish	+	Hyaline	$1\text{--}1.5 \mu\text{m}$

* Sections mounted in 2% KOH (I), H_2O (II), or Melzer's (III).

and Kajchenberg (1985) did not select the earlier Petch name. Furthermore, the implied synonymy of *P. flavomarginatus* with *Poria rickii* Bres. also appears to be incorrect. Instead, these names represent distinct species. The basidiospores of *Phellinus flavomarginatus* are larger and remain hyaline in alkali. The major differences between the four species studied are presented in TABLE I.

Recent reports (Larsen *et al.*, 1979; David *et al.*, 1982; Niemelä, 1975) strongly suggest that there are a number of misidentified taxa in *Phellinus* that are extremely similar to recognized species. Similarly, described taxa as presented here may be placed mistakenly in synonymy resulting in broad species concepts. From a recent worldwide literature survey, we determined that there are approximately 275 named *Phellinus* species, making *Phellinus* one of the largest genera of wood-destroying fungi. The large number of species and presumed homothallism with concomitant low outbreeding potential suggest a high rate of allopatric speciation.

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